Because we have a three-element circuit, we have a total of six voltages and currents that must be either specified or determined. You can define the directions for positive current flow and positive voltage drop **any way you like**. Once the values for the voltages and currents are calculated, they may be positive or negative according to your definition. When two people define variables according to their individual preferences, the signs of their variables may not agree, but current flow and voltage drop values for each element will agree. Do recall in defining your Ideal Circuit Elements (Page 41) that the **v-i** relations for the elements presume that positive current flow is in the same direction as positive voltage drop. Once you define voltages and currents, we need six nonredundant equations to solve for the six unknown voltages and currents. By specifying the source, we have one; this amounts to providing the source's **v-i** relation. The **v-i** relations for the resistors give us two more. We are only halfway there; where do we get the other three equations we need?

What we need to solve every circuit problem are mathematical statements that express how the circuit elements are interconnected. Said another way, we need the laws that govern the electrical connection of circuit elements. First of all, the places where circuit elements attach to each other are called **nodes**. Two nodes are explicitly indicated in Figure 3.6; a third is at the bottom where the voltage source and resistor **R2**are connected. Electrical engineers tend to draw circuit diagrams schematics in a rectilinear fashion. Thus the long line connecting the bottom of the voltage source with the bottom of the resistor is intended to make the diagram look pretty. This line simply means that the two elements are connected together. **Kirchhof's Current Law (Page 46),** one for voltage and one for current, determine what a connection among circuit elements means. These laws are essential to analyzing this and any circuit. They are named for Gustav Kirchhofll , a nineteenth century German physicist.

3.4.1 Kirchhof's Current Law

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At every node, the sum of all currents entering or leaving a node must equal zero. What this law means physically is that charge cannot accumulate in a node; what goes in must come out. In the example, Figure 3.6, below we have a three-node circuit and thus have three KCL equations.

$$
\begin{aligned}
-i - i_1 &= 0 \\
i_1 - i_2 &= 0 \\
i + i_2 &= 0
\end{aligned}
$$

Note that the current entering a node is the negative of the current leaving the node.

Given any two of these KCL equations, we can find the other by adding or subtracting them. Thus, one of them is redundant and, in mathematical terms, we can discard any one of them. The convention is to discard the equation for the (unlabeled) node at the bottom of the circuit.